ASSOCIATION OF DIET QUALITY, SLEEP PATTERN AND PHYSICAL ACTIVITY LEVEL WITH COGNITIVE FUNCTION OF ADOLESCENTS (16-19 YEARS) IN FARIDABAD, HARYANA

SHORT SYNOPSIS

Submitted in partial fulfilment of the requirement of the degree of

DOCTOR OF PHILOSOPHY

To

Manav Rachna International Institute of Research and Studies

(Deemed to be University)

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Certificate

I hereby declare that the short synopsis "**ASSOCIATION OF DIET QUALITY, SLEEP PATTERN AND PHYSICAL ACTIVITY LEVEL WITH COGNITIVE FUNCTION OF ADOLESCENTS (16-19 YEARS) IN FARIDABAD, HARYANA** being submitted in partial fulfilment of the requirement for the degree of Doctor of Philosophy in NUTRITION AND DIETETICS under School of Allied Health Sciences of Manav Rachna International Institute of Research & Studies, Faridabad during the academic year 2023. It is a bona fide record of original work carried out under the supervision of Dr Divya Sanghi, Professor and has not been submitted in full or part to any other university or institute for degree or diploma. Further, it is certified that short synopsis is plagiarism free and proof has been submitted.

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ABSTRACT

Adolescence (10-19 years) is a period of rapid changes physically, mentally and socially. The physical health of the adolescents is very important. Nutritionally, the adolescents need all the balance of macronutrients and micronutrients for the demanding growth. The critical role of cell proliferation, DNA synthesis, neurotransmitter and hormone metabolism are functioning due to nutrients, and they are important constituents of brains enzyme systems. Not many studies have evaluated the impact of diet quality, sleep pattern and physical activity on the cognitive levels of the adolescents. The present study aims to determine the impact of diet quality, sleep pattern and physical activity levels of the adolescents on the executive function of cognitive performance. The study will collect data from 400 adolescents in the age group of 16-19 years through random sampling method. Data will be collected from schools/colleges of Faridabad. The assessment of diet quality will be through Diet Quality Index-International (DQI-I), Sleep pattern through Pittsburgh Sleep Quality Index (PSQI), Physical Activity will be assessed through Global Physical Activity Questionnaire (GPAQ) and cognitive function will be assessed through Stroop test, Rey Auditory Verbal Learning test (RAVLT) and logical reasoning questions. The data collected will be analyzed through SPSS Version 21. The analysis will look towards the association of diet quality, sleep quality, Body Mass Index (BMI) and physical activity with cognitive function. This study will help analyze which parameter has greater association with intelligence level.

Key words: Diet quality, Sleep quality, Physical activity level, Executive function.

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1. INTRODUCTION

1.1 Definition of Adolescents

"The World Health Organization (WHO) defines an adolescent as any person between the age group of 10 and 19 years". Adolescents experience change in physical, cognitive and psychosocial growth. This affects how they experience feeling, thinking, making decisions, and interacting with the world around them. (Sethi et al.,2019)

1.2 Adolescent Diet and Health

India accounts for one fifth of the world's adolescent's population total being 253 million adolescents (10-19 years) out of 1.2 billion. Adolescents' health is of prime importance and there are many nutrition and health services in India. The services are deworming and health check-ups which are twice in a year, "Weekly Iron Folic Acid Supplementation (WIFS)", and adolescents having reproductive and mental health conditions are given counseling. School going adolescents are provided almost 1/3rd of energy requirement and protein requirements for two hundred schooldays per year by having mid-day meals which are provided by all government schools. (Sethi et al.,2019)

According to "Comprehensive National Nutrition Survey (CNNS) 2016-18", the nutritional status among adolescents' boys and girls (10-19 years) is not adequate as there is visible form of malnutrition in 1 in 2 adolescents with 10% of double burden of underweight and overweight/obesity. It is seen that girls mainly have deficiency of vitamin D, folate and iron and boys have deficiency of mainly folate, zinc and vitamin 12. There are multiple micronutrient deficiencies. 1 out of 2 adolescents suffers from at least 1 out of 6 micronutrient deficiencies (vitamin D, vitamin A, zinc, iron, folate and vitamin B12). By 12 years, more than 40 % girls are anaemic. It has been observed that the adolescents are also falling at risk of 3 common non communicable diseases. Risk of developing diabetes, cardiovascular diseases and risk if hypertension among adolescents is at rise. Around 1 out of 2 adolescents are getting affected by at least 1 of the risks. One in three adolescents face low good cholesterol problem, leading to cardiovascular risk. The food groups

are also missing from the diet of the adolescents like fruits, greens, eggs and milk. There is consumption of unhealthy foods at least 3 times a week. (Sethi et al.,2019)

The daily recommended level of physical activity for age are not met by almost all adolescents and have “unhealthy” diets.

During adolescence, negative body image is very common among girls. It is highly evident among the teen adolescents. A negative body image lead to the eating disorders risks such as anorexia nervosa, bulimia nervosa and other maladapted behaviors accompanied with other symptoms such as anxiety and depression. Person’s physical and mental health is affected as a result of these disorders; in some cases, they are life-threatening. Eating disorders among adults may lead to loss of muscle mass, body fat and bone mineral density. (Javaid and Ajmal, 2019)

The types of diet play a crucial role in our lives as they govern not only our physical health but also the mental and social health

1.3 Adolescent diet and cognition

Diet has a direct impact on the cognitive function and behavior of children and adolescents. There can be immediate or long term, both beneficial and adverse impact of nutrient composition and meal pattern (Bellisle, 2004)

Literature suggests that adolescents have better cognitive performance, who take breakfast just before a cognitive demand and regular consumption of high-quality breakfast than those who do not. Diet quality as well as diet pattern plays a critical role in cognitive development of the children. (Peña-Jorquera et al., 2021)

Diet quality is broadly defined as a dietary pattern or an indicator of variety across key food groups relative to those recommended in dietary guidelines (Wirt and Collin, 2009). Both appropriate intake profiles of all the nutrients and a low risk of diet-related Non-Communicable Diseases are reflected by consumption of High diet quality. Some of the confounding factors has an impact on diet quality like food preferences of the family and child, culture, food environment, socio economic status and nutrition recommendations relevant to age, gender, country, and/or family culture of the person. (Marshall, et al., 2014).

Diet Quality Indices (DQIs) are “assessment tools that can be used to quantify the overall quality of an individual’s dietary intake by scoring food and/or nutrient intakes, and sometimes lifestyle factors, according to how closely they align with dietary guidelines”. (Wirt and Collins, 2009)

Studies have shown that there is improvement in cognitive function only during the peri-natal period and infancy with a high intake of n-3 polyunsaturated fatty acids supplements, especially Docosahexanoic acid, but this impact is not observed in childhood or adulthood (Weiser et al., 2016).

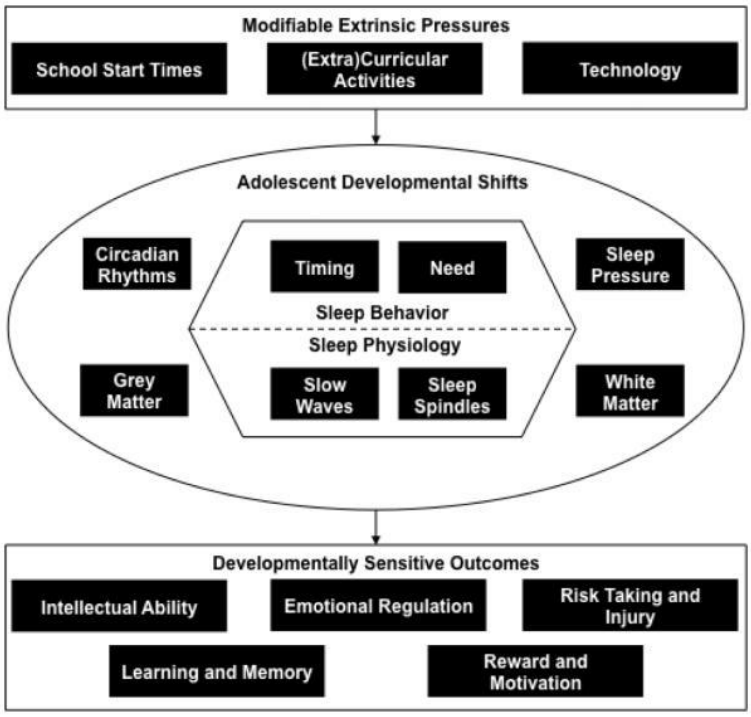
Poorer academic achievement has been seen at the age of ten years among children who had the dietary patterns, including high fast foods consumption, snacks, sausages and sweetened beverages at three years of age. (Haapala et al., 2015)

1.4 Body Mass Index and Cognition in Adolescents

The BMI is defined as the body mass divided by the square of the body height, and is expressed in units of kg/m^2, resulting from mass in kilograms and height in metres.
Body mass index shows whether a person is overweight or underweight.
Studies have shown that there is a significant positive correlation of body mass index and cognition. (Belwal et al., 2021)

1.5 Sleep quality and Cognition in Adolescents

The physiological growth spurt during adolescents is directly linked to adequate sleep. Lack of Sleep leads to drowsiness, poor attention, and has an impact on academic performance. Social schedule is one of the important factors that leads to the poor sleep-in adolescents. Sleep deprivation in adolescents is often a result of irregular activity schedule and sleep-patterns, and the shift from morning- to evening-type in circadian preference. (Roenneberg et al., 2004)



Tarokh L, Saletin JM, Carskadon MA. Sleep in adolescence: Physiology, cognition and mental health. Neurosci Biobehav Rev. 2016 Nov;70:182-188. doi: 10.1016/j.neubiorev.2016.08.008. Epub 2016 Aug 13. PMID: 27531236; PMCID: PMC5074885.

Considering that adolescence is a crucial period for neural development, it is seen that sleep deprivation and insufficient sleep has impact on brain maturation processes which leads to long lasting difficulties. (Dutil et al., 2018).

The American Academy of Paediatrics (AAP) has recommended that adolescents aged 13 to 18 years should get 8 to 10 h of sleep per 24 h regularly to promote optimal health.

1.6 Physical Activity and Cognition in Adolescents

The World Health Organization has recommended the daily recommendation for children and adolescents (ages 5 to 17 years) should include 60 minutes of moderate-to-vigorous intensity physical activity. Insufficient physical activity in adolescents is becoming a severe problem worldwide as there is a significant rise in non-communicable diseases.

Many studies have also shown that Physical activity (PA) and obesity were linked with poor cognition.

Some studies have shown that brain structures and functions, cognitive functions, and overall academic achievement are better in children and among adolescents who have high physical activity levels. (Donnelly et al., 2016)

Physical activity increases the level of many growth factors like brain derived neurotrophic factor (BDNF) and leads to increase in the blood flow, raise glucose, and lipid metabolism which also increases brain functioning.

2. Review of Literature

Haapala et al.,2015 investigated the associations of the two diet quality namely the Dietary Approaches to Stop Hypertension (DASH) and Baltic Sea Diet Score (BSDS) with the cognition in children. Both the score were calculated using 4 day food records data , higher the scores, better the diet quality. Raven's Coloured Progressive Matrices (CPM) score was used to assess Cognition, higher the scores, better the diet quality. Among all the children, the BSDS and the DASH score were positively associated with the Raven's Coloured Progressive Matrices score. Worse cognition in children was associated with poorer diet quality, and the association was stronger in boys as compared to girls.

Children and adolescents with very poor nutritional status can have improved Intelligence scores with the help of micronutrient supplementation. (Bellisle, 2004)

Another study which studies the impact of different diet pattern, it was observed 'High fat' pattern showed a negative association with cognitive ability in Chinese children as compared to positive association with 'High protein' pattern (Wang., 2021). 'High intake of protein' and 'High intake of fat' and 'High intake of salt-oil' were the three dietary patterns which were identified. The factors like age, sex, nationality, registration of household, type of school, annual household income, education level of parents, family learning environment, and family size were adjusted, it was found that 'High salt-oil' pattern had no association with mathematics score but an increase in 'High intake of protein' pattern score was associated significantly. Mathematics low scores and vocabulary tests were seen in children having 'High fat' pattern score.

In a study by Milte., et al (2019), where the assessment of diet quality and cognitive function was done in mid-aged and older men and women , it was concluded that there was no association between dietary intake and cognitive function in older adults.

A study was conducted by Isgin (2020) regarding Diet quality in adolescents with premenstrual syndrome: A cross-sectional study, in which it was observed that feeling like depression, anxiety and irregular sleep were linked with high quality diet as compared to

low quality diet. Therefore, further studies are required to investigate the relation of diet quality and presence/severity of PMS.

Tabriz et al., 2015, conducted a community-based cross-sectional study to investigate the relationship between body mass index (BMI) and cognitive function preschool children. The findings of the study showed that higher BMI scores were associated with low intelligence scores. However, socioeconomic status was one of the mediating factor.

A study conducted by Khade et al., 2021, the cognitive processes was determined on one time event using the Mini-Mental State Examination (MMSE) and BMI was calculated. It was observed that likelihood of cognitive impairment in young students (18-20 years) increased with increase in BMI.

Roberts et al, 2012 conducted a study to check the association between daily energy (calories) percentage coming from macronutrients and incident mild cognitive impairment (MCI) or dementia. The subjects having high % of carbohydrate intake had high risk of MCI or dementia, but in the fully adjusted models, the risk was reduced in subjects having high % of fat, and high % of protein. A study on the relationship between cognitive decline and caloric intake has shown that there is a reduced risk of mild cognitive impairment when there is high protein intake.

Findings have shown that globally around 85% of girls and 78% of boys have recommendations of at least 1 hour of physical activity per day which they do not meet (published by The Lancet Child & Adolescent Health journal and World Health Organization, WHO).

In a study by Peña-Jorquera et al., 2021, it was observed that low cognitive performance was negatively linked in obese/ overweight adolescents who were not taking breakfast regularly.

A study conducted by Vizayieno Casavi et al.,2022 have shown that In the study, the sleep quality assessment by Insomnia Severity Index (ISI) scale. The cognitive and emotional maturity was assessed by by Emotional Maturity Scale (EMS) and Montreal Cognitive Assessment (MoCA). It was concluded that the emotional performance and cognition of the adolescence are directly influenced by sleep deprivation. The person suffering from chronic sleep-deprivation may suffer from symptoms like fatigue, frequent weight gain or weight loss, daytime sleepiness, and clumsiness.

Herting and Chu , 2017, have found that the brain structure and function and cognitive performance of the adolescents are impacted by routine exercise. Studies suggest that optimal adolescent brain development, physical activity and aerobic exercise are important factors. There is a direct link between physical activity and cognition in adolescents.

A study by Bacaro et al., 2023, showed that school performance was negatively associated with high social jetlag, the short sleep-duration and later bedtime during the weekdays and weekends.

3. Description of Topic

Adolescence is a last period of rapid growth and development. The diet during adolescence is of prime importance as it impacts their future health. Unhealthy diet leads to many problems like overweight, obesity, cardiovascular problems etc. Unhealthy diet also has impact on the cognitive health of the adolescents which can lead to early age problems like Alzheimer's and Dementia. The cognitive health is not only impacted by the unhealthy diet but also due to inadequate sleep and physical activity.

The Comprehensive National Nutrition Survey (CNNS) 2016-18 – from birth to adolescence dataset provides detailed information regarding inadequate micronutrient intake and imbalance of macronutrients along with change of dietary habits, available approach to services like school, nutrition and health) and pattern of physical activity during adolescence (for both boys and girls in the age group of 10-19 years).

Lack of physical activity and eating disorders are associated with high risk of non-communicable diseases during adulthood. Rapid increase in cognitive and emotional development is an important part of body changes and nutrition plays an important role.

The study aims to find out the association between the three factors namely diet quality, sleep quality, physical activity level with cognitive function of the adolescents.

4. AIM and OBJECTIVES

AIM: The study aims to find the association of diet quality, physical activity and sleep quality with executive function: attention, memory and reasoning of the adolescents in the age group of 16-19 years

OBJECTIVES:

1. To assess the nutrient intake pattern and diet quality of study participants
2. To determine the sleep quality and physical activity level of study participants
3. To evaluate the cognitive functions (attention, memory and logical reasoning) of study participants
4. To find the association of diet quality, sleep quality, physical activity with cognitive function of study participants

Alternative Hypothesis

1. There will be statistically significant impact of nutrient intake pattern and diet quality on the cognitive function of the study participants.
2. There will be statistically significant impact of sleep quality on the cognitive function of the study participants
3. There will be statistically significant impact of physical activity level on the cognitive function of the study participants

Null Hypothesis

1. There will be no statistically significant impact of nutrient intake pattern and diet quality on the cognitive function of the study participants.
2. There will be no statistically significant impact of sleep quality on the cognitive function of the study participants
3. There will be no statistically significant impact of physical activity level on the cognitive function of the study participants

5. METHODOLOGY

5.1 Locale of Study:

Area of the study is considered as general locations and conditions where data collection takes place in the study. The present study will be conducted in Faridabad, Haryana. The Faridabad zone will be divided in four zones respectively, North, South, East and West. The sample will be collected from all the four zones

5.2 Target Population:

The target population of the study will be late adolescents' girls and boys of either gender (Late Adolescents: 16-19 years)

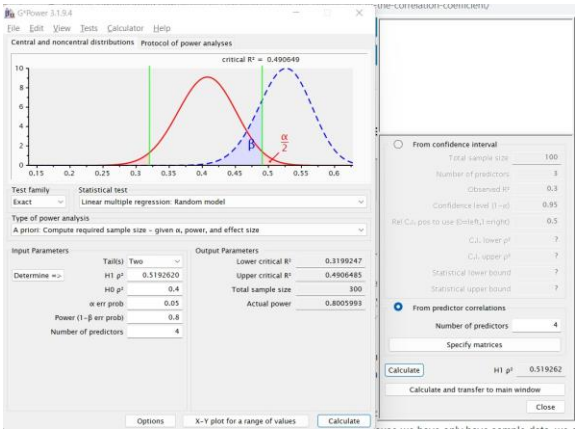
5.3 Sample: A sample should represent the characteristic of the universe. In this study, adolescent in the age group of 16-19 years will be selected from private schools/colleges of Faridabad**.**

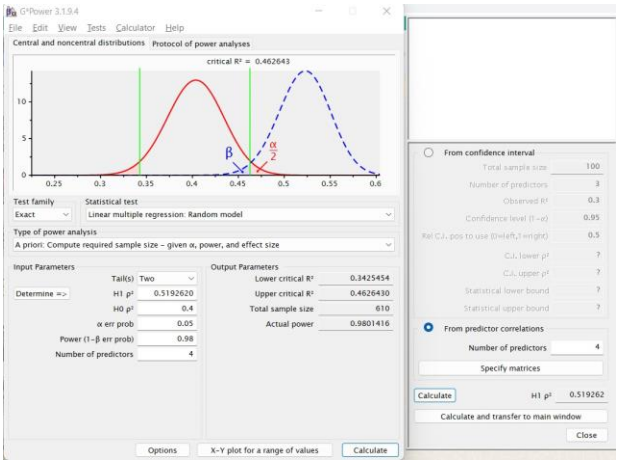
5.4 Study Design: Cross-Sectional study

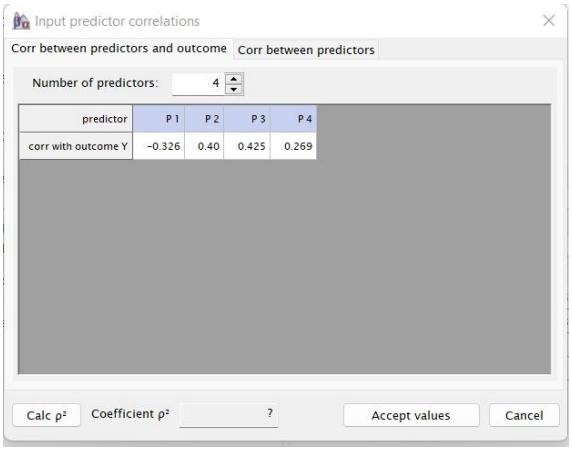
5.5 Sampling Technique: Stratified Random Sampling

5.5.1 Sample size: the sample calculated is 350 samples (calculated from G power) with 80% power

So considering 15% dropout: 400 samples







5.5.2 Inclusion criteria:

1) adolescents in the age group of 16-19 years

2) Adolescents from both the gender: girls and boys will be included

3) Adolescents attending school/college regularly from past 3 months

4) Adolescents willing to participate

5.5.3 Exclusion criteria:

1) Adolescents who are unwilling to participate
2) Adolescents who are not on any specialized or restricted diet
3) Adolescents studying in government school and college.
4) Adolescents suffering from psychiatric illness or under any antidepressant medicine
5) Adolescents reporting any occurance of life events like accidents during last 3 months that might have impacted the mood or daily rhythm.
6) Adolescents with any neurological disorders like autism, epilepsy or psychiatric disorder

5.6 Tools and Techniques

Following tools will be used to collect the data

5.6.1 **Anthropometric measurements** including height, weight and indices like Height for age, Weight for Height, Weight for age and Body Mass Index

5.6.2 **Dietary Intake and nutrient intake pattern** would be assessed through standardized 3-day 24-hour dietary recall and (FFQ) Food frequency questionnaire. Assessment of **Intake of all the macronutrients (carbohydrates, proteins and fats) and micronutrients (iron, Vitamin B9 (folate), vitamin B12, vitamin D, vitamin A and also zinc)**.Along with detailed profiling of **essential amino acids (methionine, tryptophan, threonine, valine, isoleucine, lysine, phenylalanine, lysine) and essential fatty acids (omega 3 and omega 6 fatty acids) through 3 day dietary recall method and in blood (on subsamples).**

5.6.3 **Diet Quality** assessment through Diet Quality Index-International

The DQI-I is a composite, individual-level diet quality indicator. It was developed in 2003 to identify the cross-cultural diet quality comparisons, which have not been done before using diet quality composite indicators (Kim et al., 2003). The DQI-I is a combination of indicators, such as the Healthy Eating Index and the Diet Quality Index (DQI), but was formulated to incorporate quality in the diet which includes

- Variety / Diversity: within and across food groups
- Adequacy: according to the requirements, sufficiency of nutrients or specific food groups consumption
- Moderation: some specific nutrients or foods that should be consumed with moderately
- Overall Balance: macronutrient intake composition.

5.6.4 **Sleep Quality** Assessment would be conducted through Pittsburgh Sleep Quality Index

The **Pittsburgh Sleep Quality Index** (**PSQI**) is a self report questionnaire that assesses sleep quality over a 1-month time interval. The measure consists of 19 individual items, consisting 7 components that provides one global score, and takes around 5–10 minutes

to complete. Developed by University of Pittsburgh researchers. Studies have shown that PSQI exhibits high test-retest reliability and also has a good validity for insomnia patients. (Backhaus et al., 2002)

Each of the questionnaire's 19 self-reported items belongs to one of seven subcategories:

- subjective sleep quality,
- sleep latency,
- sleep duration,
- habitual sleep efficiency,
- sleep disturbances,
- use of sleeping medication, and
- daytime dysfunction.

5.6.5 Physical Activity level would be assessed using Global Physical Activity Questionnaire (GPAQ)

The Global Physical Activity Questionnaire was developed by World Health Organization for physical activity surveillance in different countries. It collects information in three settings or domains physical activity participation as well as sedentary behavior, comprising 16 questions (P1-P16). Studies have shown that for monitoring physical activity in population health surveillance systems, GPAQ is a suitable and acceptable instrument (Bull et al., 2009). The domains are:

- Activity at work
- Travel to and from places
- Recreational activities

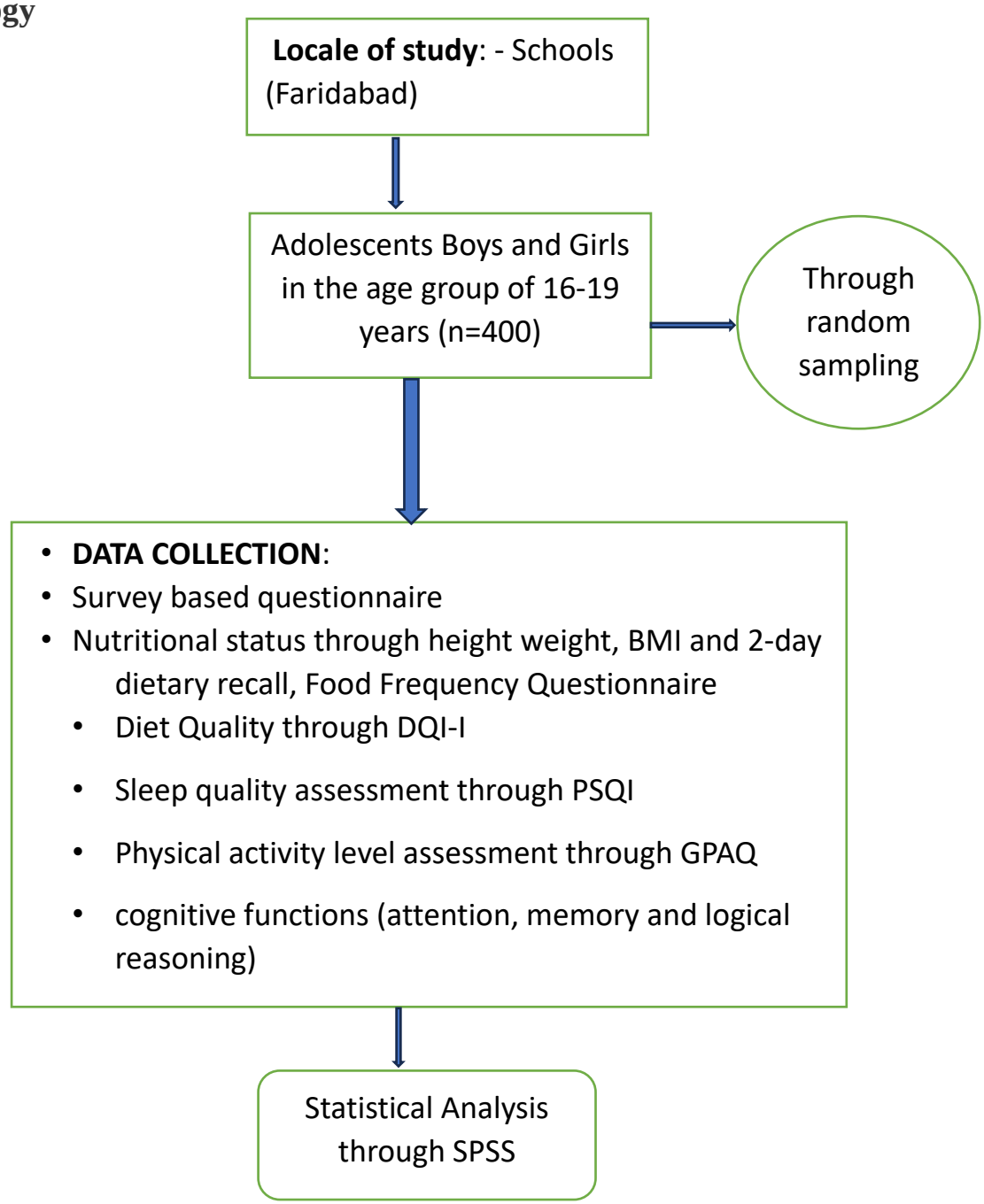
5.6.6. Cognitive function namely attention, memory and logical reasoning would be assessed through Rey auditory verbal learning test, Stroop test and reasoning questions.

The Rey Auditory Verbal Learning Test (RAVLT), a neuropsychological test used in assessment of verbal memory in people (16 years of age and above) The RAVLT is used to assess the memory dysfunction severity and to trace changes in memory function over time. 15 word list are given which are presented five times which is followed by repeated

recall. This is followed by a another 15 word list (interference list B), then followed again by list A recall. Delay in recall and re-cognition are tested. Studies have shown that
For neuropsychological assessment, RAVLT is taken as a valid and reliable psychometric instrument. (De Sousa et al., 2012)

Stroop test is a type of neuropsychological test used to assess selective attention and inhibitory control. The test is attempted in various psychological research and diagnostics. The Stroop Colour and Word Test is a neuropsychological assessment (executive function) which was developed by John Ridley Stroop and first published in 1935. The Stroop effect is the delayed reaction time between congruent and incongruent stimuli. In condition one, the name of the colour event, the subjects are presented with a series of the word written in red, green, blue or yellow ink. Subjects are required to, as fast as they can, verbally tell the ink colour in which the letter is written.
In condition 2, the colour-word interference condition, subjects are shown words like "red," "green", "blue," or "yellow," but these words written in different ink colour than the word. The subjects need to tell the colour of the ink fast and accurately. In condition 3, the negative priming condition, the ink colour of all the words is alike to the colour word stimulus on the last item. (Erdodi, 2018)
Logical reasoning questions will be validated on the sub samples of the adolescents. The questions will be framed from the previous years CUET questions which are for class 12^{th} students.

Methodology


Locale of study: - Schools (Faridabad)
Adolescents Boys and Girls in the age group of 16-19 years (n=400)
Through random sampling
DATA COLLECTION:
Survey based questionnaire
Nutritional status through height weight, BMI and 2-day dietary recall, Food Frequency Questionnaire
Diet Quality through DQI-I
Sleep quality assessment through PSQI
Physical activity level assessment through GPAQ
cognitive functions (attention, memory and logical reasoning)
Statistical Analysis through SPSS

6 Expected outcome of the study

The proposed study is planned to assess the following

- This study will appraise the current situation of Diet quality and physical activity level and sleep quality of the target sample
- This study will estimate the present state of cognitive function of the target sample
- The study will help to relate the impact of Diet quality, physical activity level and sleep quality on the cognitive function of the target sample

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